Universal Journal of Environmental Research and Technology
 eISSN 2249 0256
Available Online at: **www.environmentaljournal.org**
Volume 3, Issue 2: 152-157

Open Access **Research Article**

Ecological Evaluation of Seasonal Dynamism in Physicochemical Characteristics of Tropical Reservoir in Central India

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Abstract:

The present study was carried out to make an ecological evaluation of physico – chemical characteristics in Barna reservoir during various seasons. Barna reservoir is a tropical reservoir which is constructed on river Barna, a tributary of river Narmada in central India. For evaluation of seasonal changes in water quality of Barna reservoir water samples were collected on monthly basis for a certain period from January 2009 to December 2009 and a total of 19 parameters were analyzed according to standard methods. The results revealed that the ecology of Barna reservoir in different seasons showed dynamism in physico – chemical parameters which could be due to various factors like input of fertilizers, weathering of rocks, meteorological phenomenon and other activities in catchment area.

Keywords*:* eutrophication; primary productivity; river Narmada

1.0 Introduction:

Water is one of the ubiquitous elements in world that support vitality in every ecosystem whether it is aquatic, terrestrial or aerial. Water quality of any aquatic ecosystem can be better understood through information about it`s physical, chemical and biological regime. Aquatic ecosystem is the most varied ecosystem hence it`s hydrobiology vary one to another water body. The physicochemical properties of water and co – related dependence of all vital activities make it mandatory to take an account of it`s hydrobiological investigation to understand ecology of a reservoir. Present study deals with an evaluation of water quality in terms of physicochemical characteristics of Barna reservoir, a tropical reservoir meant for irrigation purpose and fisheries activity. It was constructed by damming the river Barna, a tributary of river Narmada on NH – 12 near Bari village in Raisen District of Madhya Pradesh. It is surrounded by good forest cover at its periphery as well as human settlement.

Table 1: Some important morphometric features of the Barna reservoir

Location	Raisen, Madhya Pradesh
Latitude/ Longitude	23°5'N/78°7'E
Year of construction	1975
River	Barna (Narmada Basin)
Catchment Area	1176 Sq. Km
Dam Height	47.7 m.
Dam Length	432 m.
Dam Type	Masonry
Full Reservoir Level (FRL)	348.55 m.
Water spread at FRL	7700 ha.
Sources of Water	Rain Water
Purpose	Irrigation, Aquaculture

2.0 Material and Methods:

To investigate seasonal dynamism in physico – chemical characteristics in four seasons i.e. Winter, Pre – monsoon, Monsoon and Post – monsoon; analysis of certain parameters have been done following the method given as APHA (1998) and manual developed by Adoni (1985). Sampling was done for certain period from January 2009 to December 2009 on monthly basis at four selected sampling stations viz. Dam site (S – 1), Middle of Dam (S – 2), Tail End of Dam (S – 3) and Down Stream (S – 4).

3.0 Results and Discussion:

The seasonal variations in physico – chemical parameters are presented in table 2. During present investigation water depth have been observed in range of 1.67 m in pre – monsoon season at S – 4 to 25.37 m during post – monsoon season at S – 2 with an average of 13.0±8.65 m. The atmospheric temperature varied from 24°C in winter season at S

– 4 to 39.7°C in pre – monsoon season at S – 2 with an average of 31.5±5.3°C. In monsoon season the colour of reservoir water was brown though during post – monsoon it turns green and greenish yellow in winter and again green during pre – monsoon season. Water, always almost odorless but smell with fishy odor in monsoon season and pungent smell in pre – monsoon season. During the study, water temperature ranged from 21.3°C in winter season at S – 4 to 32.3°C during pre – monsoon season at S – 2 with mean value of 26.0±3.9°C. Transparency ranged between 63.7cm in winter season at S – 4 to 118 cm in post – monsoon season at S – 2 with the mean value of 93.3±18cm. In Barna reservoir, turbidity ranged between 166 NTU in post – monsoon season at S – 1 to 185 NTU during pre – monsoon season at S – 4 with an average of 176.7±7NTU.pH ranged between 7.8 during winter season at S – 4 to 8.13 in post – monsoon season at S – 1 & S – 3 with an average of 7.9±0.1. Electrical conductivity recorded between the range of 219 µmhos in post – monsoon season at S – 1 to 244 µmhos in pre – monsoon season at S – 4 with an average of 232.5±9.2µmhos. The amount of TDS ranged between 109 mg/l in post – monsoon season at S – 4 to 126 mg/l during pre – monsoon season at S – 3 with an average value of 117.5±5.6 mg/l. On over all studies free CO_2 found in very low amount and some time absent though maximum value 3 mg/l with mean of 2.1±0.5 mg/l observed during post – monsoon season. During present investigation total alkalinity ranged from 85.5 mg/l during pre – monsoon season at S – 1 to 140 mg/l in winter season at S – 3 with an average of 123.0±13.9 mg/l. Dissolved oxygen observed between 5.7 mg/l in post – monsoon season at S – 1 to 11.1 mg/l in pre – monsoon season at S – 3 with an average of 8.0±1.43 mg/l. In Barna reservoir, the BOD ranged between 0.4 mg/l during pre – monsoon season at S – 2 & S – 3 to 1.9 mg/l in post – monsoon season at S – 1, S – 2 & S – 4 with an average of 1.1±0.52 mg/l. Total hardness ranged from 49.6 mg/l in pre – monsoon season at S – 1 to 128 mg/l during monsoon season at S – 3 with an average of 94.4±20.2 mg/l where as calcium hardness and magnesium content values ranged between 51.8 mg/l during winter season at S – 1 to 75.1 mg/l in pre – monsoon season at S – 1 with an average of 61.6±7 mg/l and 18 mg/l in post – monsoon season at S – 1 to 55.9 mg/l during monsoon season at S – 3 with an average of 37.1±11.1 mg/l respectively. In Barna reservoir, the amount of nitrate content ranged from 0.1 mg/l to 0.4 mg/l during monsoon season at S – 3 with an average of 0.2±0.1 mg/l following the decreasing trend in all seasons and at all sites. Ortho – phosphate vary from0.3 mg/l during winter season to 2.1 mg/l in pre – monsoon season at S – 1, monsoon season at S – 3 and in post – monsoon season at S – 3.

Water depth is mainly depended on accumulation of water caused by the rains in the catchment area. Water depth is always found maximum in post – monsoon season after monsoonal rainfall when water reaches from various sources and stabilizes while water depth decreases in pre – monsoon season due to evaporation and supply for irrigation. Air temperature a totally meteorological phenomenon demarcate variable seasons like cold winter season followed by scorching hot summer/pre – monsoon season, inception of rain i.e. monsoon season and post – monsoon season as end of rain. These seasons directly or indirectly influence biological activities in an ecosystem. Colour and odor are the attributes of actions taking place in water like infestation of algal bloom gives greenish appearance in water and smell in water could be due to decomposition within the aquatic resource. Water temperature corresponds to atmospheric changes as also observed in Barna reservoir, low water temperature found in winter season may be because of low atmospheric temperature and high water temperature recorded during pre – monsoon season was probably due to low water level, high intensity of solar radition and clear atmosphere. Similar observation has been recorded by Jawale and Patil (2009), Narayana et. al (2008) and Anita et. al. (2005). In Barna reservoir maximum transparency was recorded during post – monsoon season because of increase in water level and less turbidity while minimum transparency was observed during winter season due to high planktonic growth that leads to high turbidity and similar observation about transparency was made by Kadam et. al. (2007). Turbidity resultant of suspension of particles in water acting as obstacle in light penetration was observed maximum during pre – monsoon season due to various human activities, decrease in water level and high amount of suspended particulate matter whereas minimum turbidity was recorded during post – monsoon season which could be due to settlement of silt, clay and heavy suspended particles, similar results were obtained by Bhatt and Negi (1985). pH in Barna reservoir seemed alkaline throughout the study at almost all sites. As pH is

indicative of primary productivity level of the ecosystem and therefore the present pH level indicates moderate primary productivity. Similar findings were reported by Korai et. al. (2008).

Electrical conductivity a key factor for determining the purity of water was observed maximum during the pre – monsoon season and minimum during post – monsoon season. as electrical conductivity is a potential sign of presence of ionizing substance in water clearly indicate the status of mineral and nutrient present in water, in case of Barna reservoir it reflects productive ecosystem to harbor the flora and fauna. Similar results were obtained by Dixit (1989) in Tighara lake. TDS, the chemical constituent of edaphically contributed productivity (Goher, 2002) was reported with maximum value during pre –monsoon season due to increase in rate of evaporation of water that leads to high concentration of dissolved solids which is an indication of nutrient enrichment. Pandey et. al. (2012) also reported high amount of TDS during pre – monsoon season which decreases as dilution of water increases. Free CO_2 which shows directly inverse proportional relationship with dissolved oxygen and primary productivity was not observed in appreciable amount in Barna reservoir pointing an indication of increasing potential productivity. According to Gawas et. al.(2006) the total alkalinity gives a fair idea of natural salts present in water as carbonates, bicarbonates and hydroxide content. In Barna reservoir the maximum value of total alkalinity was found during winter season may be because of leaching of rocks and guanodeposition as it is a nesting ground for migratory birds, leading to eutrophication. Similar observations were made by Kumar (1993) while studying the physico – chemical features of Kunjwani pond. In present study the value of dissolved oxygen was found maximum during pre – monsoon that may be due to mechanical churning, increase in algal biomass and accelerated rate of photosynthesis which indicates increasing productivity of reservoir. Masood and Krishnamurthy (1990) also made similar observations while studying the hydrobiology of Wohar reservoir. In Barna reservoir the BOD is very low as compared to BOD values encountered in typical tropical lake in central India, in similar agroclimatic regions. Upper lake in Bhopal has average BOD of 5 mg/l which receives organic waste from population around it. According to Sankar et. al. (2002) the high BOD may be due to the amplification of oxygen demand for the degradation of the organic wastes dumped in to the water but in Barna reservoir the amount of dissolved oxygen is comparatively more which reflects that the water of Barna reservoir is free from organic waste hence showing less microbial degradation activity. Maximum value of total hardness observed during monsoon season might be because of leaching of rocks in catchment area and similar observations were made by Pawar and Pulley (2005) in a study carried out on Pethwadaj Dam, Nanded and Kaushik and Saxena (1991) also found similar results while studying water quality of Surajkund, Gwalior. Sirsath et. al. (2006) affirmed that cations of calcium and magnesium are foremost components that determine the amount of total hardness. According to Ohle (1956) on the basis of calcium content, water resources can be categorized in to: (i) poor, (ii) medium and (iii) rich water body. Maximum amount of calcium during Pre – monsoon season may be due to rapid oxidation and decomposition of organic matter. Similar results were reported by Verma et. al.(2011) while analyzing Kankaria Lake, Ahmedabad. According to Venkatasubramani and Meenambal (2007), magnesium is often associated with calcium in all kinds of waters but its concentration remains generally lower than the calcium, similarly,in Barna reservoir similar trend was observed. According to Wetzel (1975) low magnesium content is possibly due to it`s uptake by the plants in the formation of chlorophyll – porphyrin metal complexes and in enzymatic transformation.

Level of nitrate – nitrogen in surface water often reflects obvious seasonal fluctuations with higher concentrations being found during Monsoon season compared to Pre – monsoon, Post – monsoon and Winter. During Pre – monsoon season, decrease in the amount of nitrate content may be due to algal assimilation and other biochemical actions and high amount of nitrate content during Monsoon season possibly due to agricultural surface runoff and domestic sewage from catchment area. Similar observations were made by Wolfhard and Reinhard (1998); Das (2000); Das (2003) and Sehgal (2003). High amount of phosphate content in Pre – monsoon season may be due to low level of water and pollution where as high value of phosphate during Monsoon season is mainly due to rain, surface water runoff, agricultural runoff and other local sources. Similar results were reported by Arvindkumar (1995) and Kamal et. al. (2007).

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Table 2: Seasonal Variation in Physico - chemical Parameters of Barna Reservoir of Central India

S. No.	Parameter Name	Winter				Pre - monsoon				Monsoon				Post - monsoon				Max.	Min.	Mean	SD(±)
		S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4				
1	Depth	19.4	21.2	7.4	2.33	17.03	17.8	4.57	1.67	20.67	22.3	7.9	3	23.33	25.37	11.33	3.13	25.37	1.67	13.0	8.65
2	Air Temp.	25	26	25	24	37.7	39.7	38.3	37	33.7	35.7	34.3	33.7	28.3	29.7	28.3	27.3	39.7	24	31.5	5.3
3	Colour	GY	GY	GY	GY	G	G	G	G	B	B	B	B	G	G	G	G				
4	Odor	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL				
5	Water Temp.	21.3	22.7	22	21.3	32	32.3	32	31	25.7	27	27	25.7	23	24.7	24.7	23.3	32.3	21.3	26.0	3.9
6	Transparency	64.3	70.7	67.3	63.7	88	111.3	109.3	89.7	95	98	97	95	108	118	111.7	105.7	118	63.7	93.3	18
7	Turbidity	172.5	173.5	174.5	175.1	185.2	184.7	185.2	185	176.3	176.8	183.9	182.7	166.4	166.7	169.7	168.2	185.4	166	176.7	7
8	pH	7.9	7.9	8	7.8	7.9	7.9	8	7.9	7.93	7.9	8	7.9	8.1	8	8.1	7.9	8.13	7.8	7.9	0.1
9	Electrical Conductivity	227	228.3	229.7	230.3	243.7	243	243.7	244	232	232.7	242	240.3	219	219.3	223.3	221.3	244	219	232.5	9.2
10	TDS	112.3	116.7	118.7	121	121.7	122	126	125	118.7	118.7	122.7	116.7	109.3	109.7	111.7	109	126	109	117.5	5.6
11	Free CO_2	2	2	Abs	Abs	2	2	Abs	Abs	2	2	Abs	Abs	3	Abs	Abs	Abs	3	2	2.1	0.5
12	Total Alkalinity	120	127.3	140	134.7	85.5	120	134	125	101.3	114.7	126	118	126.7	128.7	139.3	126.7	140	85.5	123.0	13.9
13	D.O.	6.9	7.3	8.5	7.3	9.2	9.6	11.1	8.4	8	8.4	9.6	7.3	5.7	6.3	7.9	6.3	11.1	5.7	8.0	1.43
14	BOD	1.3	1.2	0.7	1.2	0.5	0.4	0.4	1.1	1.2	1.07	0.5	1.6	1.9	1.9	1.2	1.9	1.9	0.4	1.1	0.52
15	Total Hardness	76.7	78.7	86.7	82	49.6	94.7	102	96	107.3	120	128	122.7	73.3	92	102.7	97.3	128	49.6	94.4	20.2
16	Calcium Hardness	51.8	53.9	58.1	51.8	75.1	62.3	66.5	60.2	65.8	67.9	72.1	67.2	55.3	57.4	63.7	56.7	75.1	51.8	61.6	7.1
17	Magnesium Content	24.9	24.8	28.6	30.2	45	32.37	35.5	35.8	41.5	52.1	55.9	55.5	18	34.6	39	40.6	55.9	18	37.1	11.1
18	Nitrate-Nitrogen	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.1	0.2	0.2	0.4	0.1	0.1	0.2	0.3	0.1	0.4	0.1	0.2	0.1
19	Ortho - Phosphates	0.1	0.1	0.2	0.1	0.3	0.1	0.2	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.3	0.1	0.3	0.1	0.2	0.1

*Parameter No.1expressed in m, Parameter No. 2 & 5 in°C, Parameter No.6 in cm, Parameter No.7 in NTU & Parameter No.9 represented in µmhos
**From Parameter No.10 to 19 are expressed in mg/l
OL = Odor less, GY = Greenish Yellow, G = Green, B = Brown

Universal Journal of Environmental Research and Technology
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Available Online at: **www.environmentaljournal.org**
Volume 3, Issue 2: 152-157

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4.0 Conclusion:

On evaluation of seasonal variability in physico – chemical characteristics in Barna reservoir conclusion can be drawn that the aquatic ecology of Barna reservoir not only has fairly good potential productivity but also supports rich biota.

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